PIBS 4374e

A SUMMARY OF AIR MONITORING IN THE BEACHVILLE AREA

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Executive Summary

Local air emissions can have a large variety of health effects on the people of Ontario, as well as impacts on the environment. To manage air quality issues at the local level and meet its commitment to ensure effective abatement and enforcement, the Ministry of the Environment uses a range of strategies to enhance conformance with ambient air quality criteria.

In the Beachville area, the source of the main air quality concern – particulate matter – derives from the operation of local quarries and the manufacturing of cement and lime. Problems associated with high levels of particulate matter are: damage to agricultural crops, vegetation, homes; corrosion; reduced visibility and potential impacts on human health.

The Ministry has been monitoring particulate matter in the Beachville area for many years to assess air quality in the community and determine the sources and levels of the particulate emissions. This report is based on all air monitoring carried out by MOE from 1975 to summer 2002.

The key results of MOE's long-term studies and the special study conducted in 2002 in the Beachville area are highlighted below:

- Ambient air quality criteria (AAQC) for particulate matter in the Beachville area are being exceeded more frequently than in most other locations in Southwestern Ontario.
- In most cases, particulate levels show higher averages in the Beachville area than at other Southwestern Ontario monitoring stations.
- Assessing the data against the benchmarks set in the Ambient Air Quality Criteria (AAQC) for Ontario indicates levels are high enough to justify additional abatement and monitoring initiatives in the Beachville area.
- Research and data show that quarrying operations and the manufacturing of cement and lime are the main sources of particulate pollution in the Beachville area.

The Ministry has shared results of the study with the Medical Officer of Health to exchange information and to ensure that any potential health concerns are addressed.

A detailed action plan has been developed and is now being implemented by the Ministry of the Environment to prevent increases in particulate levels and lower particulate concentrations to acceptable levels. The primary components of the action plan to improve air quality are:

- The Ministry will conduct annual site inspections and review industries' reports to ensure compliance.
- Each company is to install a continuous monitoring network for particulate matter by March 31, 2003.

- The Ministry will have direct access to this monitoring data.
- The Ministry will perform random audits of the monitoring equipment and verification sampling.
- On an ongoing basis, the Ministry will work with community stakeholders such as the Zorra Aggregate Advisory Committee and report on the results of monitoring programs and air quality improvements to them annually.

PART 1: CONTEXT

Background

The atmosphere contains a wide variety of particulate matter (dust). These particles come from man-made and natural sources, are composed of many different compounds, and range considerably in size. They may be liquid or solid, and may be formed locally or come from long distances away. Particles can be responsible for corrosion, soiling, damage to vegetation, reductions in visibility and can have potential health effects.

In the case of Beachville and the surrounding area, studies have shown that the community has been exposed to elevated levels of particulate matter. The Ministry of the Environment (Ministry or MOE) has been monitoring air quality for many years to determine the basis of this concern and to isolate its causes. There are a number of sources that contribute to the levels of particulate in this area including roads, agriculture, quarry operations and the manufacturing of cement and lime.

Particulate matter is the primary air pollutant associated with quarry operations and the manufacturing of cement and lime. The cement industry is considered an extractive industry, since nearly all of the raw materials are obtained from the earth's crust by quarrying. Most cement plants are located near a source of calcium carbonate, which is most often limestone. The operations include rock drilling, blasting, excavation, loading, hauling, crushing, screening, materials handling, processing, stockpiling, and storing. Because of the raw materials used, almost every operation in this industry has the potential for dust emissions. The three main manufacturing and quarry operations are: Carmeuse Lime-Beachville Limited; Federal White Cement Limited; and LaFarge Canada Inc.

Review of the historical data has shown that local sources make a significant contribution to elevated particulate levels in the Beachville area's ambient air. Sources of particulate matter (called "fugitive sources") include storage piles, quarry work faces, processing operations, both on-site and off-site transportation, and re-entrained particulate from the areas around the quarry.

In Beachville, elevated levels of particulate are strongly correlated with higher levels of calcium compounds in the particulate. Relatively low levels of silicate in the particulate strongly suggest that native dust from country roads and agricultural soil are not major contributors to the elevated particulate.

Although a number of air pollution control measures have been implemented by the local industries, the particulate levels in the area have recently increased and now regularly reach levels that exceed Ministry criteria.

Particulate Monitoring

Traditionally, particulate monitoring has been conducted by operating two or more HiVol samplers. This method requires sampling for at least one year, but often several years of sampling are necessary to ensure results are not biased by varying meteorological conditions. Since the HiVol samplers yield a 24-hour sample and wind direction may vary over the sampling period, the correlation with wind direction and the source is very difficult to determine. The total time involved in the assessment of compliance and reporting can extend to at least two years, during which time a source may have repeatedly exceeded air criteria. This type of monitoring allows one to determine if standards have been exceeded, but it generally cannot point to the specific source of the emission.

During the summer of 2002, the Ministry temporarily replaced its monitoring program in the Beachville area by replacing the traditional 24-hour samplers with state of the art real-time particulate analyzers that ran continuously for a period of up to sixty-four days. The new analyzers are able to distinguish between particulate sizes and sample once every six seconds. This advanced type of monitoring technology can pinpoint individual sources and assess their impacts. In addition, real-time monitoring provides instantaneous results so that air quality conditions can be observed, analysed and reported in a timely manner.

Continuous particulate analyzers, with dedicated meteorological equipment, have many benefits over traditional HiVol sampling. Each real time particulate analyzer can sample at a frequency of six seconds to one hour, measure three different particulate sizes ($PM_{10,}$ $PM_{2.5,}$ PM_1) and simultaneously record the meteorological data. This allows for a more accurate record of compliance that can be addressed quickly and efficiently. Turn around time for results ranges from one to three months and the exceedences of standards can be registered at the time of the release. The other benefit from this type of monitoring is the continuous stream of particulate and meteorological data which can result in a more efficient and timely abatement of the source by the company.

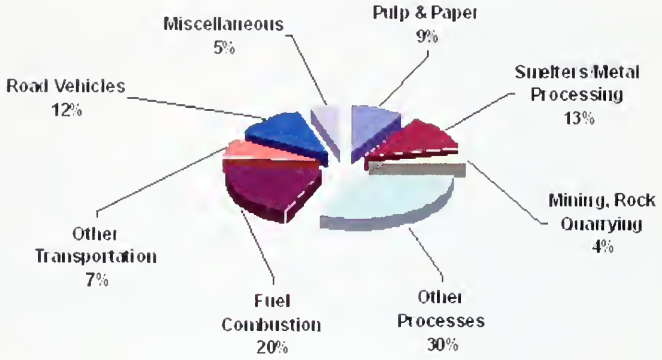
Background - Atmospheric Particulate

Atmospheric particles are sometimes characterized by size (aerodynamic diameter) because this is related to potential health effects they may produce. Most particles greater than 10 microns will be caught in the nose and throat, never reaching the lungs. Inhalable particulate (PM_{10}) may reach the upper respiratory tract and will be caught by cilia lining the walls of the bronchial tubes, which will move the particles up and out. Respirable particulate ($PM_{2.5}$) matter can penetrate deeper into the lungs, into regions where there are no cilia. Some removal mechanisms operate in the pulmonary region but retention times are between one and two years. The body's natural defenses against airborne particulate are geared towards larger particles, and as a result smaller particles more easily bypass them. Moreover, the smaller the particle, the deeper into the respiratory tract and lung it may penetrate. The greatest effect on health is from particles PM_{10} and $PM_{2.5}$, which can aggravate bronchitis, asthma and other respiratory conditions. People with asthma, cardiovascular or lung disease, children and elderly people are considered to be the most sensitive to the effect of particles.

Total Suspended Particulate (TSP) is a generic term for airbourne particles including smoke, fume dust, fly ash and pollen. Composition varies with place and season but normally includes soil particulates, organic matter and nongaseous sulphur and nitrogen compounds. Their diameter is approximately 0.1 to 100 microns (millionth of a metre).

The term PM_{10} (inhalable particulate) has been given to the part of the total suspended particulate that has a diameter of ten microns or less. This has been determined to be the particle size which is most likely to be inhaled and deposited into the respiratory system. PM_{10} is emitted from a variety of sources (see Figure 1). Industrial sources include fuel combustion, energy production, incineration, construction, mining, metal smelting and processing. Urban contributors include vehicle exhaust, residential wood combustion and road dust. Natural sources include wind blown soil, forest fires, volcanic activity and ocean spray.

Figure 1 - Ontario PM-10 Emissions by Major Sector



The term $PM_{2.5}$ (respirable particulate) has been given to the part of the total suspended particulate that has a diameter of 2.5 microns or less. Ambient $PM_{2.5}$ is usually formed from chemical reactions in the atmosphere and through combustion processes. However, mechanical and other processes can also contribute to it. Particulate control equipment is usually less efficient at removing small particles.

Benchmarks/Guidelines/Criteria for Particulate Matter in Ontario:

The Ambient Air Quality Criteria (AAQC) for Ontario is the maximum concentration or level (based on potential effects) of a contaminant that is desirable or considered acceptable in ambient air. The table below shows the particulate size with its respective concentration, sample and exposure periods, which form the basis of the AAQC. The following is a description of each criterion displayed in Table 1:

- The desirable level of Suspended Particulate is 120 micrograms per cubic metre ($\mu g/m^3$) over a 24 hour period.

- The annual AAQC of 60 $\mu g/m^3$ is based upon the geometric mean of 24 hour samples collected over a full year. Geometric mean provides a indication of the central tendency for a small data set with extreme values and is calculated by taking the nth root of the product of all (n) values in a data set.

- Under Ontario Regulation 346, sources are required to limit their emissions of suspended particulate matter, such that the concentration mathematically predicted at a point-of-impingement (POI) does not exceed 100 $\mu g/m^3$ in any half hour period. The ½ hour POI is meant to exclude the normal presence of background particulate levels. The ½ hour POI is mainly used for emission modeling and not monitoring results, and for that reason was not used as a standard in this report.

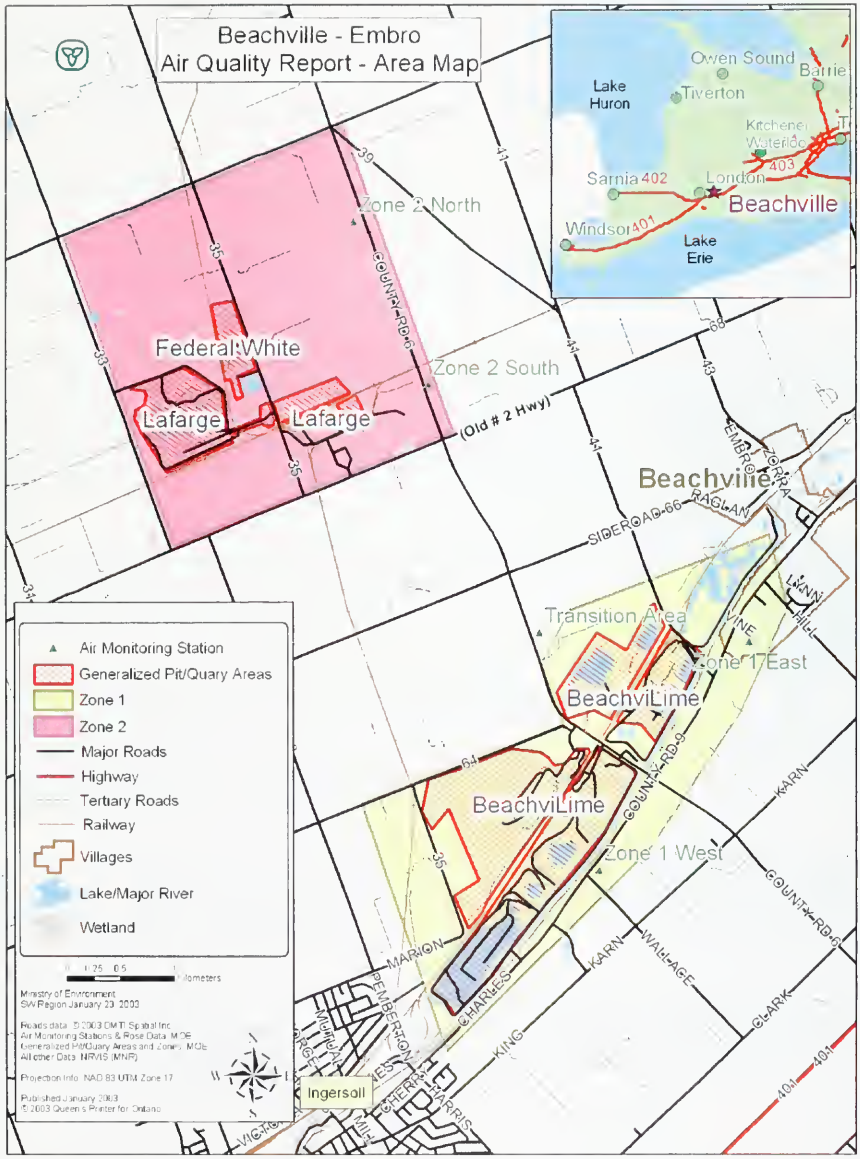
- On November 18, 1997, Ontario introduced an interim AAQC for PM_{10} of 50 $\mu g/m^3$ based on a 24-hour average. The PM_{10} interim AAQC was based upon the potential health effects and serves as Ministry policy to provide guidance for environmental protection decisions in Ontario.

- The Canada Wide Standard (CWS) concentration for 24-hour $PM_{2.5}$ is 30 $\mu g/m^3$. The standard for $PM_{2.5}$ is based on a complex calculation that involves using the 98th percentile of the measurements annually, averaged over three consecutive years. The $PM_{2.5}$ CWS was agreed by all provinces and is to be achieved by the year 2010. We have used the CWS simply as a benchmark when considering 24 hour sample results, since we have not undertaken the longer term sampling necessary to make valid comparisons. For this summary, the CWS will be referred to as Canada Wide Standard Benchmark (CWSB).

Table 1 - Summarizing the standards and Ambient Air Quality Criterions:

Particulate Size	Criteria	Sampling Duration
Suspended Particulate (Total)	120$\mu g/m^3$	24 hour AAQC
Suspended Particulate (Total)	60 $\mu g/m^3$	1 year geometric mean AAQC (annual AAQC)
Suspended Particulate	100 $\mu g/m^3$	½ hour Point-of-Impingement
PM_{10}	50 $\mu g/m^3$	24 hour interim AAQC
$PM_{2.5}$	30 $\mu g/m^3$	24 hour Canada Wide Standard

Figure 2 - Beachville Area Overview Map



PART 2: TECHNICAL FINDINGS

The Ministry has been monitoring air quality in the Beachville area for many years in order to assess air quality in the community, as well as to determine the source and levels of the particulate emissions. This report is based on all air monitoring carried out by the Ministry from 1975 to summer 2002. A appendix for this report, which contains additional information such as sampling descriptions, statistical methods and data, is available upon request.

Beachville HiVol Sampling Trends

Most of the data presented in the report were collected from 1989 to 2001. The Ministry has data for two stations that were collected earlier and are presented in this report in order to ensure completeness.

TSP is monitored with a instrument called a HiVol sampler (Figure 3) for a period of twenty-four hours, once every six days. A HiVol sampler draws air through a filter at the rate of approximately 40 cubic feet per minute. The (daily) mass concentration of total suspended particulate matter is computed from the mass of collected particles and the volume of air sampled.

Figure 3 - HiVol Sampler

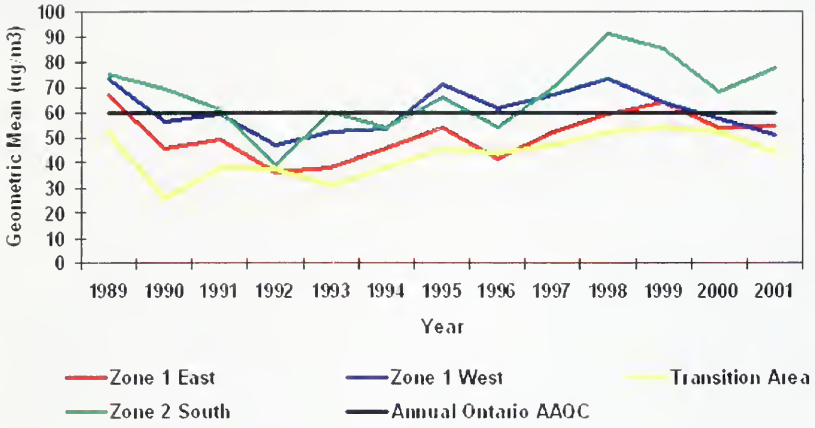
For the purpose of this summary, the Beachville area was divided into two zones of influence. All sampling locations and geographical zones are depicted in Figure 2.

Zone 1 as seen in Figure 2 has been defined as the area that comprises all of Carmeuse Lime-Beachville facilities/quarries that are located in the valley between the Town of Ingersoll and the Village of Beachville, north of County Road 9. Zone 1 has two sampling stations one in the west end called Zone 1 West and the other located in the east end called Zone 1 East.

Zone 2 as seen in Figure 2 has been defined as the area that encompasses the Federal White facility and LaFarge facility/quarries. It is located north of County Road 2 and west of County Road 6. Zone 2 has two sampling stations one in the south end called Zone 2 South and the other in north end called Zone 2 North.

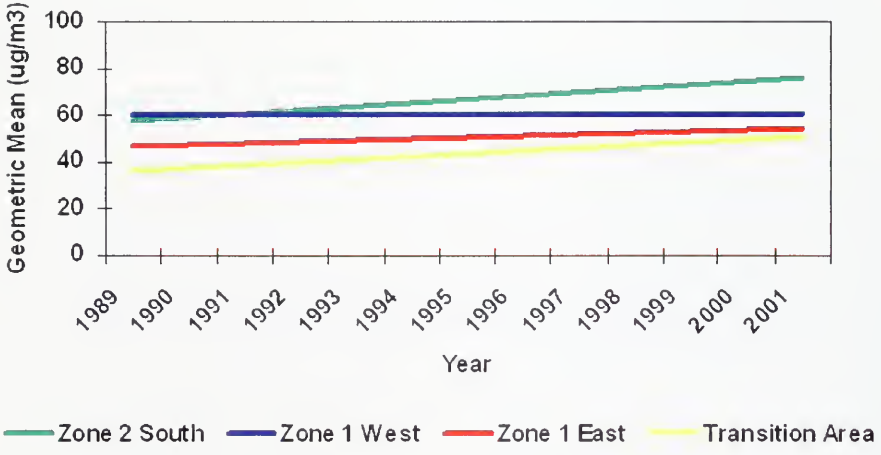
Figure 4 shows a graph of the annual geometric mean AAQC levels (annual AAQC) for total suspended particulate at all sampling stations in the Beachville area. The last five years Zone 2 South has exceeded the Ontario annual AAQC and presently is the only monitoring location that currently still above the annual AAQC

Figure 4 - Annual TSP Levels for Stations in the Beachville Area



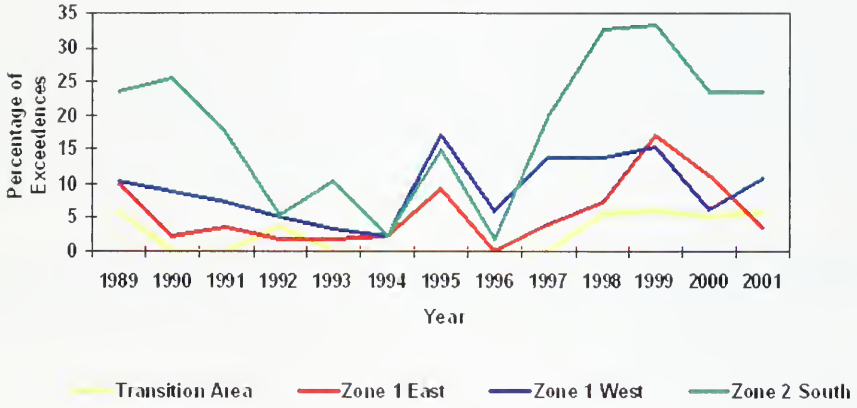
A trend analysis shown in Figure 5 indicates that the TSP concentrations at all stations have been climbing since 1989. Results in Zone 2 South exceed the annual AAQC, while Zone 1 West concentration trends have been consistently at the annual AAQC of 60 $\mu g/m^3$.

Figure 5 - TSP Concentration Trends for Stations in the Beachville Area



Exceedences of the 24 hour AAQC of 120 µg/m^3 are shown in Figure 6. Since 1996 all five sampling locations are showing yearly exceedences at rates higher than most other sampling sites in Southwestern Ontario. As shown in Figures 4, 5 and 6, Zone 2 South has the highest concentrations, trends and percentage of exceedences of the sampling locations in the Beachville area.

Figure 6 - Percentage of 24 Hour Exceedences of the AAQC for Stations in the Beachville Area



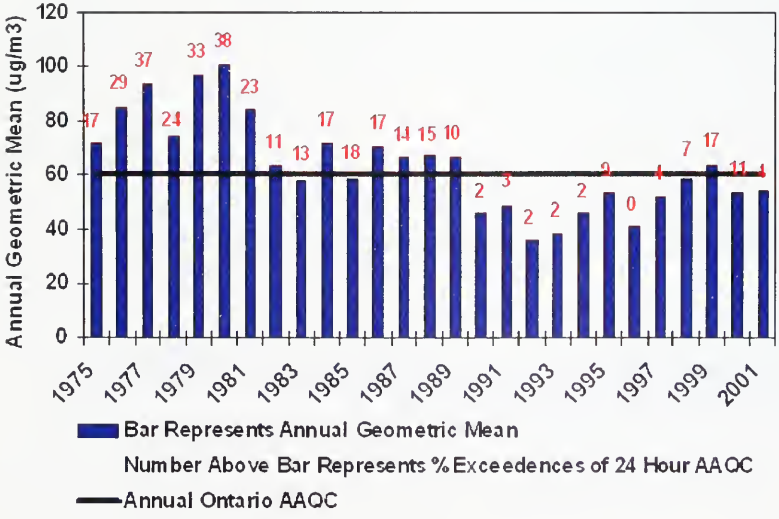
Zone 1 East

The monitoring station in Zone 1 East is located at Vine St in Beachville (Figure 2), and is ½ km from Carmeuse Lime-Beachville. It has additional samplers for particulate and monitoring equipment for wind speed and direction and ozone measurement. The old site was on top of a school which closed forcing the relocation of the samplers approximately 125 metres away. This site is situated downwind from all three quarries. These samplers are primarily subject to the influence of what is now the Carmeuse Lime-Beachville (Zone 1) quarries and manufacturing of cement and lime. The data from this station provides a good indication of potential impacts of particulate matter on the community of Beachville.

As can be seen from the Figure 7, the geometric mean levels (blue bars) from 1975 to 1981 were constantly above the annual AAQC and exceedences of the 24 hour AAQC (red number above blue bars) occurred approximately thirty percent of the time. The levels declined from 1982 to 1988, however the annual and 24 hour AAQC continued to be exceeded. The next eight years (1990 to 1997) showed considerable improvement in the air quality for Zone 1. The annual AAQC was not exceeded and the 24 hour AAQC was surpassed only approximately three percent of the time. Over the last four years, the levels have since trended upwards, though the former higher levels have not been observed.

There is a general upward trend in this case and the levels tend to be higher than in Zone 1 West. The 24 hour AAQC was exceeded nine percent of the time during the sampling period, which is equivalent to an average of about thirty-four days per year, during the last four years.

Figure 7 - Long-Term Monitoring in Zone 1 East

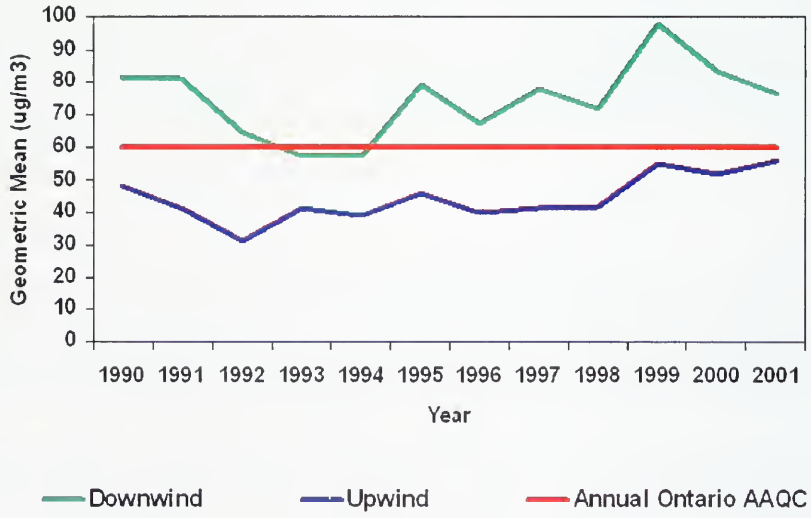


Zone 1 East - Directional Sampling

There are two HiVol samplers in the Beachville area that were placed to compare the impact of the quarry operations and the manufacturing of cement and lime to other possible sources. They are co-located in Zone 1 East in the Village of Beachville. They are specially modified HiVol samplers designated as Downwind and Upwind. The Downwind operates only when winds are blowing from the quarries and cement plants while Upwind operates only when winds are blowing from directions other than from the quarries and cement plants. The data from this station provides a good indication of potential impacts of particulate matter on the community of the Village of Beachville.

As seen in Figure 8, samples from Downwind, which measures contributions from the quarries and the manufacturing of cement and lime, consistently record much higher particulate levels than samples collected from Upwind. The annual geometric means for Downwind are higher (often by fifty percent), 24 hour AAQC exceedences are more common, and the annual AAQC has been exceeded for the last six years. These results are consistent with other downwind Beachville sampling results, linking the quarries and the manufacturing of cement and lime to high particle concentrations.

Figure 8 - Upwind/Downwind Contribution in Zone 1 East



Zone 1 West

The monitoring station in Zone 1 West is located directly south across County Road 9 and is approximately ¼ km from Carmeuse Lime-Beachville quarries (Figure 2). The data from this station give a good indication of potential impacts of particulate matter on the rural community, between the Town of Ingersoll and the Village of Beachville.

This station frequently records higher levels of particulate than in Zone 1 East. The 24 hour AAQC was exceeded twelve percent of the time during the sampling period, which is equivalent to an average about forty-three days per year, during the last four years. This station has shown a steady decline in particulate levels for the last four years.

Transition Area Between Zone 1 and Zone 2

The monitoring station is located on County Road 6, about two kilometres north of County Road 9 (Figure 2). It represents a transition station between Zone 1 and Zone 2. The station is approximately ½ km from Carmeuse Lime-Beachville (Zone 1), 2 ½ km from LaFarge and 3 ½ km from Federal White (both Zone 2). The data from this station give a good indication of potential impacts of particulate matter on the rural community located in the transition area.

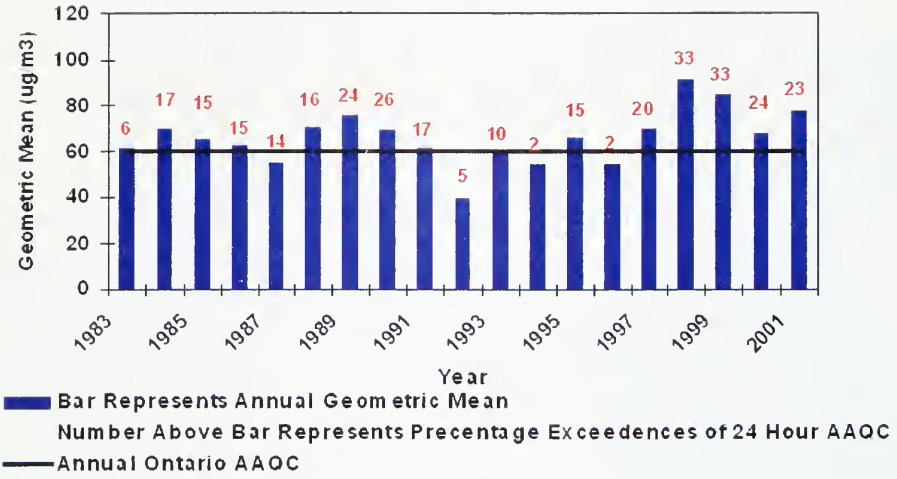
The 24 hour AAQC was exceeded approximately five percent of the time during the sampling period, which is equivalent to an average of about twenty days per year, during the last four years. While the annual AAQC has not been exceeded, the current trend suggests it will be exceeded within three or four years. Correlation of this data with wind direction suggest that road dust contributes as much as the quarries and manufacturing of cement and lime. Road dust could encompass field soils (from agriculture), quarry particulate matter on vehicles, re-entrainment of dust and transportation emissions. Although deposition studies were not undertaken, field staff noted at times the paved roads and nearby vegetation were covered by a film of white dust, especially during dry periods in the summers.

Zone 2 South

The monitoring station in Zone 2 South is located on County Road 6, about ½ km north of Highway 2 in Zorra Township (Figure 2). It is approximately 1 ½ km from Federal White and ¾ km from LaFarge. The data from this station provides a good indication of potential impacts of particulate matter on the rural community located downwind from LaFarge and Federal White.

As seen in Figure 9, sampling at this site started in 1983. During the first nine years of sampling the annual AAQC was exceeded eight times and the 24 hour AAQC was exceeded approximately sixteen percent of the time. In 1992, Zone 2 South recorded its lowest annual level ever, and was approximately thirty percent lower than the annual AAQC. Similar results were recorded in Zone 1 East. During the last five years, the annual concentrations of particulate have increased in Zone 2 South. Exceedences of the 24 hour AAQC ranged from twenty to thirty-three percent of the time.

Figure 9 - Long-Term Monitoring in Zone 2 South



Like all monitoring zones and areas, there is a high degree of year to year variability, but levels in Zone 2 South are higher than most other Southwestern Ontario stations. The 24 hour AAQC was exceeded twenty-eight percent of the time during the sampling period, which is equivalent to an average of about one hundred and four days per year, during the last four years. This station was fifty percent above the annual AAQC in 1998, indicating significant contributions from nearby sources.

PM_{10} and Calcium HiVol Sampling at Zone 2 North

Twenty-four hour PM_{10} samples are collected by a modified Hi-Vol sampler outfitted with a size selective inlet to restrict particle size to less than ten microns. This sampler uses quartz filters, which allows for further chemical analysis of the particulate for calcium, which cannot be done with regular HiVol filters.

The monitoring station is located in Zone 2 North on County Road 6, approximately 1 ½ km north of Zone 2 South station (Figure 2). It is approximately 1 ½ km from the Federal White and LaFarge facilities. The data from this station provide a good indication of potential impacts of particulate matter on the rural community, located downwind from the LaFarge and Federal White facilities.

Table 2 illustrates the data from this station. While only three years of complete data (1998 highlighted because of low number of samples) are available, it is apparent that the site is significantly effected by fine particulate. In fact, in 1999 it had the highest annual average PM_{10} concentration of all PM_{10} HiVol stations in Southwestern Ontario. It exceeded the Ministry's interim (24 hour) AAQC seven times.

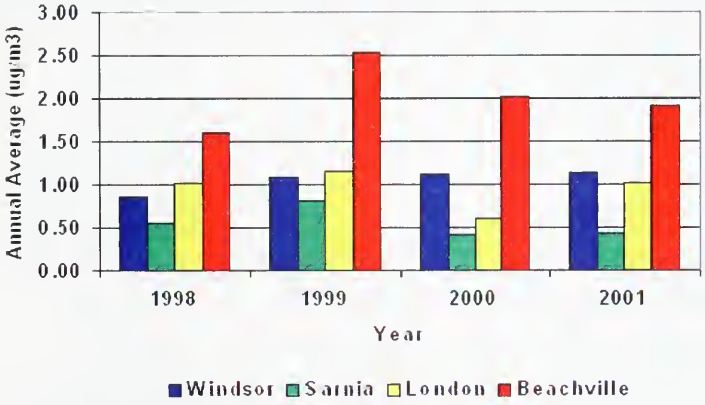
Table 2 - PM_{10} Data Summary in Zone 2 North

PM_{10} Zone 2 North				
Year	Average ($\mu g/m^3$)	Maximum ($\mu g/m^3$)	Samples Collected	24 Hour AAQC Exceedences
1998	19.78	46	18	0
1999	35.20	218	49	7
2000	29.33	93	46	3
2001	25.08	104	52	4

Metal levels in Zone 2 North were mostly low compared to levels at other sites around the region. This is to be expected as the local industry is not metal-based. The exception was calcium. A comparison of all the PM_{10} HiVols located in Southwestern Ontario shows that this station has had the highest average calcium concentrations in each year it has been in operation. Average calcium levels, in 1999 and 2000, were a factor of two higher than anywhere else in the region. This is illustrated in the Figure 10. The results from this station are shown in red.

No standard exists for calcium or calcium carbonate and calcium in small amounts is beneficial. Limestone consists largely of calcium carbonate. Processed into lime, its major constituent is calcium oxide. It is to be expected that these two chemicals will constitute the majority of the species emitted by the quarries and associated operations. Using calcium as an indicator, the data confirms that the sources associated with quarry operations and the manufacturing of cement and lime are the main local contributors of particulate.

Figure 10 - Annual Average Calcium Concentrations in PM10 Samples



Continuous Particulate Monitoring

Starting on June 4th, 2002 the Ministry of the Environment installed five *GRIMM Continuous Dust Monitors* (Figure 11) in the Beachville area. They were operational for a period up to 64 days. These instruments have been designed for continuous unattended operation and can determine levels of PM_{10}, $PM_{2.5}$ and PM_1 simultaneously. The instruments are capable of storing 6 second to 1 hour averages for extended periods and the results can be made available anytime. The GRIMM instruments were installed at all existing Beachville stations and ran in place of the HiVol samplers. Table 3 summarizes the sample results.

Figure 11 - Dust Monitoring System

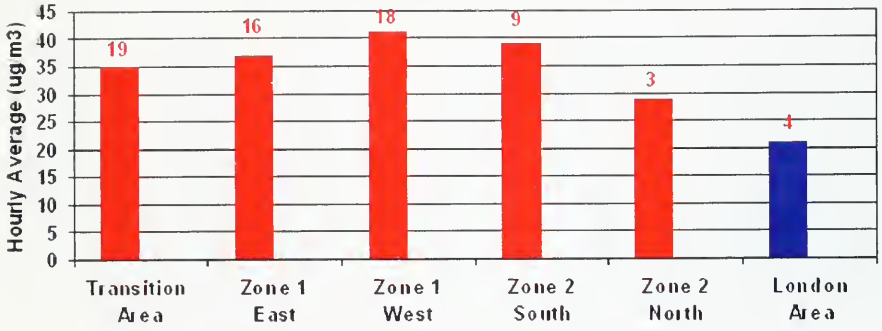
Table 3 - PM_{10} and $PM_{2.5}$ Data Summary for Beachville and Southwestern Ontario Stations

Summary of 24 Hour Data for PM_{10}						
Monitoring Location	**Transition Area**	**Zone 1 East**	**Zone 1 West**	**Zone 2 South**	**Zone 2 North**	**London Area**
Sample Days	27	56	17	35	60	47
Hourly Average ($\mu g/m^3$)	35	37	41	39	29	21
Interim AAQC Exceedences	5 (19%)	9 (16%)	3 (18%)	3 (9%)	2 (3%)	2 (4%)

Summary of 24 Hour Data for $PM_{2.5}$					
Beachville Stations					
Monitoring Location	**Transition Area**	**Zone 1 East**	**Zone 1 West**	**Zone 2 South**	**Zone 2 North**
Sample Days	27	56	17	35	60
Hourly Average ($\mu g/m^3$)	22	21	25	25	18
Canada Wide Standard Benchmark Exceedences	6 (22%)	13 (23%)	6 (35%)	8 (23%)	4 (7%)
Southwestern Ontario Stations					
Monitoring Location	**Windsor 1**	**Windsor 2**	**Windsor 3**	**Sarnia Area**	**Tiverton Area**
Sample Days	62	60	64	62	60
Hourly Average ($\mu g/m^3$)	19	16	18	16	12
Canada Wide Standard Benchmark Exceedences	10 (16%)	8 (13%)	12 (19%)	8 (13%)	4 (7%)

Figure 12 is a graph of PM_{10} averages for the sampling period for each station. The bar represent the 1 hour average concentration in $\mu g/m^3$ and the number above the bar represents the percentage of time the 24 hour interim AAQC for PM_{10} was exceeded. The red bars, which represent the Beachville stations, all showed a higher level of PM_{10} than the blue bar which represents the London station. Four out of five Beachville stations showed higher frequency of exceedences of the interim 24 hour AAQC than the London station.

Figure 12 - PM10 Hourly Averages and Percent Exceedences of 24 Hour Interim AAQC



Bar Represents Hourly Average Concentrations

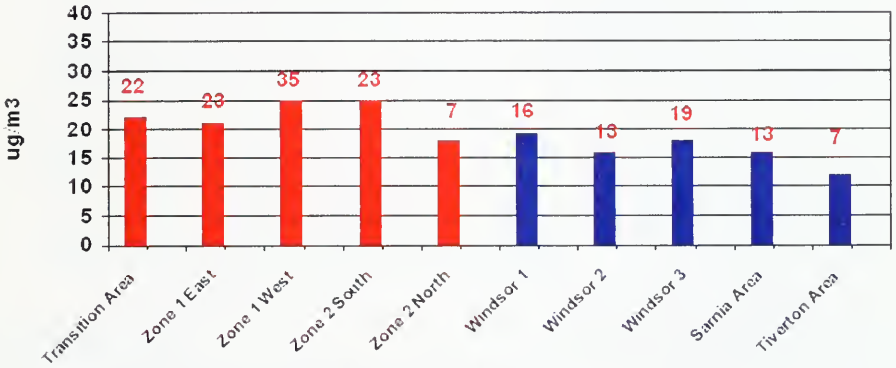
Number Above Bar Represents Percentage of Exceedences of 24 Hour AAQC

The location of the other monitoring sites are:

- Windsor 1 — West Windsor across Detroit River from US Steel
- Windsor 2 — Windsor Air Quality Index (AQI) station downtown
- Windsor 3 — West Windsor AQI station near US Steel
- Sarnia — Sarnia AQI Station near Blue Water Bridge
- London — London AQI near Fanshawe College
- Tiverton — Tiverton near the Bruce Nuclear Plant and a rural station

Figure 13 is a graph of $PM_{2.5}$ averages for the sampling period for each station. The bars represent the 1 hour average concentration in $\mu g/m^3$ and the number above the bar is the percentage of time the 24 hour Canada Wide Standard Benchmark for $PM_{2.5}$ was exceeded. The red bars, which represents the Beachville stations, show a higher level of $PM_{2.5}$ particulate then the blue bars, which represent other stations in Southwestern Ontario. The exceedences of the interim 24 hour AAQC are also higher at four of the five Beachville monitoring stations, than those at other Southwestern Ontario stations.

Figure 13 - PM2.5 Hourly Averages and Percent Exceedences of 24 Hour CWSB



Bar Represents Hourly Average Concentrations
Number Above Bar Represents Percentage of Exceedences of 24 Hour CWSB

A comparison was also made of the 24-hour averages (calculated from one-hour averages) with the appropriate AAQC for PM_{10} and CWSB for $PM_{2.5}$. Calculations were performed for each day during the sampling period, for which there was at least 22 hours of valid data. The PM_{10} comparison is based on the Ontario 24-hour interim AAQC of 50 $\mu g/m^3$. The $PM_{2.5}$ comparison is based on using the 24-hour Canada Wide Standard Benchmark of 30 $\mu g/m^3$. Examination of this data reveals the following:

- All the Beachville area stations exceeded the 24 hour AAQC for PM_{10} and the 24 hour CWS Benchmark for $PM_{2.5}$ at some time.

- The percentage of time that PM_{10} was above the interim 24 hour AAQC of 50 $\mu g/m^3$ was nineteen percent in the transition zone, sixteen to eighteen percent in Zone 1 and three to nine percent in Zone 2 (London station was four percent).

- The percentage of time that $PM_{2.5}$ was above the 24 hour Canada Wide Standard Benchmark of 30 $\mu g/m^3$, was twenty-two percent in the transition zone, twenty-one to twenty-five percent in Zone 1 and eighteen to twenty-five percent in Zone 2 (Sarnia station was thirteen percent and Windsor stations were thirteen to nineteen percent).

- All the stations showed higher PM_{10} 24 hour AAQC exceedence rates than the London station.

- All the stations showed higher $PM_{2.5}$ 24 hour CWSB exceedences rates that other Southwestern Ontario stations, except station Zone 2 North.

- The $PM_{2.5}$ levels at the "cleanest" Beachville site were only slightly better than those seen at Windsor 1 West located directly across Detroit River, from US Steel.

- Zone 2 North showed the fewest exceedences in all size ranges, when compared to other Beachville stations.

- Zone 1 West showed the highest percentage of PM_{10} and $PM_{2.5}$ 24 hour exceedences, when compared to other Beachville stations.

- Only Zone 2 North showed a lower $PM_{2.5}$ exceedence rate than any of the Southwestern region stations and it only was lower than one of them.

Pollution Roses

A pollution rose is a graph (Figure 14) that depicts pollution and wind direction in a given area. In this case, the pollution rose is a cross tabulation of hourly particulate data with the corresponding wind direction data. Wind direction information reflects winds which blow towards the center of the rose diagram. The length of each line represents the percent of time that the wind blows from each direction, the varying widths of the line show how often the pollution was light (narrow line) or heavy (wide line). The data depicted in Figure 15 clearly show that higher levels are associated with quarry operations and the manufacturing of cement and lime.

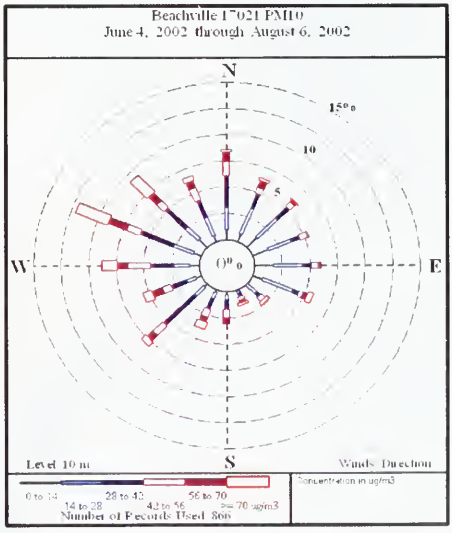
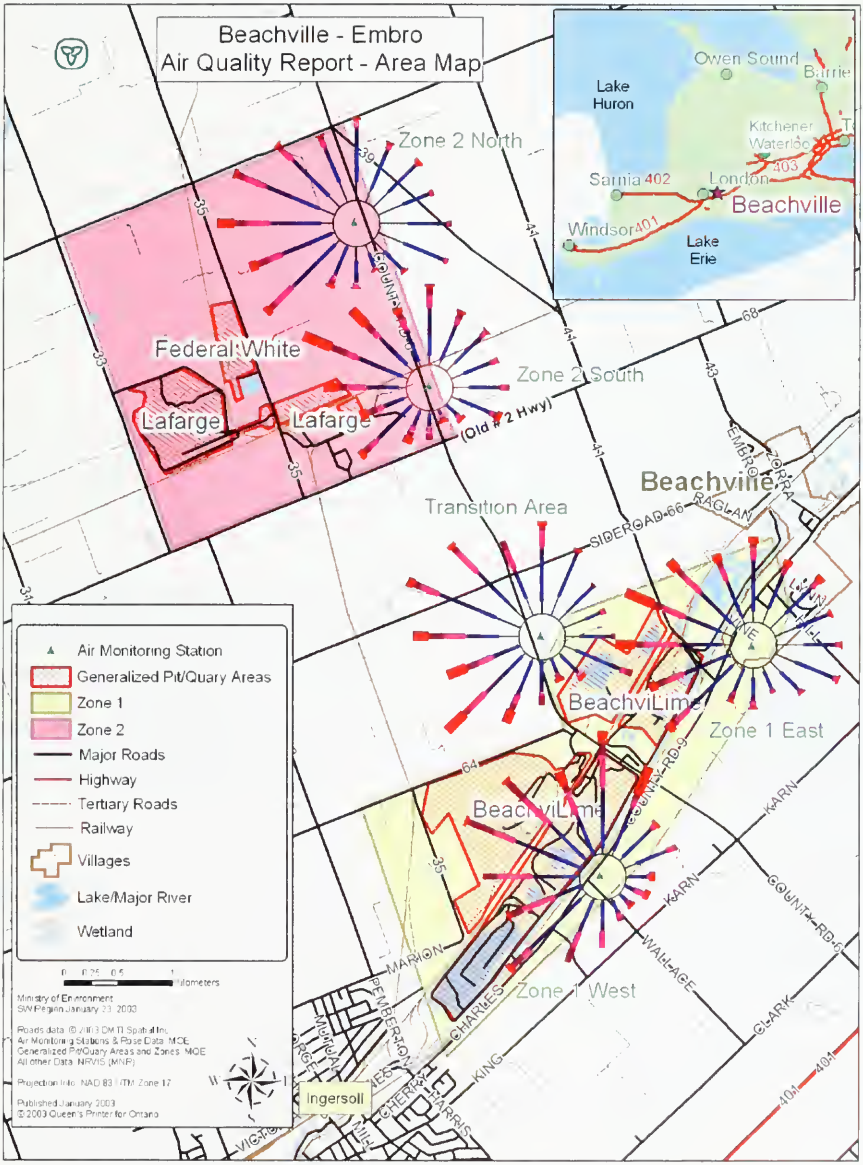


Figure 14 - Pollution Rose Graph

Figure 15 - Overview and Pollution Rose Map



Long Range Transport

Since the deployment of the real-time particulate monitors did not include monitors that would permit "upwind" measurements, the relative contributions of the local sources and long range transport can only be inferred. In particular, since this set of data was taken during the summer, when air quality alerts were common, it is important to determine how much of the measured particulate was due to local influences, compared to long range transport.

While the earlier data showed the relationship of calcium levels to wind direction, and the directional HiVols show a pronounced directional effect, it is still worth examining the fine particulate data to see if a relationship can be discerned.

How levels of particulate vary with air quality "Alerts" is of particular interest, since the number of air quality alerts reached an all time high during the summer of 2002. One might argue that air quality based on ozone and particulate levels are related. The London station ozone was chosen for this comparison, as ozone is the parameter that has triggered all the air quality alerts in Ontario.

Statistical tests showed that no significant relationship exits between particulate levels in Beachville and London ozone levels (and hence AQI). Examination of the data also shows that even at the London AQI station, ozone and particle concentration do not correlate well. Therefore, one could conclude that particulate levels in Beachville show little connection to Ontario Smog Alerts, caused by ozone concentrations.

A similar comparison between particulate levels in the Beachville area and the London station was also examined. In summary, the Beachville sites show a varying correlation with the London AQI site particulate levels. This relationship appears to be strongest when both sites monitored wind directions that were upwind of quarries or the manufacturing of cement and lime sites. The sample locations that were downwind of quarries or the manufacturing of cement and lime showed much lower correlations with London. Therefore this comparison shows that background levels are similar and that the quarries or the manufacturing of cement and lime are a significant contributor to the particulate levels.

Conclusions and Observations

A summary of air monitoring in the Beachville area using data summaries for HiVol samples taken during the period 1989-2000 and statistics based on one hour averages of real time (GRIMM) data for a 64 day period, during the summer of 2002 are presented.

- Particulate levels in the Beachville Area regularly exceed Ministry ambient air quality criterions (AAQC).
- Particulate concentrations appear to be climbing at all of the Beachville HiVol stations.
- Directional HiVols data, chemical analysis of particulate matter and pollution rose analysis of GRIMM data, lead to the conclusion that wind directions associated with quarry operations and the manufacturing of cement and lime, are associated with higher particulate levels than wind from other directions.
- Hourly data of PM_{10} and $PM_{2.5}$ at the five Beachville area stations indicate (with a few exceptions) higher levels of these particulate matter than other real time stations in Southwestern Ontario.
- Comparison of these data with various benchmarks indicates that levels are sufficiently high to warrant further action.
- Zone 1 particulate levels have improved significantly since 1975, but current trends (since 1991) suggest they are increasing and slowly approaching the annual AAQC.
- Zone 2 particulate levels show greater particulate impacts than Zone 1 and Zone 2 South shows notably higher impacts from the sources than in Zone 2 North.
- Measurements taken at the transition station located between Zone 1 and Zone 2 shows a larger impact from transportation. It should be noted that a large volume of product is transported by roads from Zone 1 to Zone 2.
- Field staff have observed high dust concentrations on County Road 6 and on nearby vegetation and buildings.
- Quarry operations and the manufacturing of cement and lime in the Beachville area contribute significantly to the elevated particulate levels that regularly exceed Ministry of the Environment annual and 24 hour AAQC.

PART 3: Ministry of the Environment Action Plan

The ministry's abatement action plan is designed to continuously move forward on improving the air quality in the Beachville area by working with the local industry and other stakeholders. This plan will assist the Ministry and industry in identifying areas where the industries need to concentrate their efforts in pollution reduction both immediately and over the long-term. The following abatement plan outlines the course of action that the Ministry will take to improve the air quality in the Beachville area.

Pro-active Inspection Program

The Ministry will continue to conduct annual proactive inspections at each of the three industries to determine compliance with Certificate of Approval and legislated requirements. In addition, MOE will do a detailed review of the companies' reports to ensure compliance with the Airborne Contaminant Discharge - Monitoring and Reporting Regulation (Ontario Regulation 127/01). Non-compliance issues will be handled with the use of appropriate MOE abatement tools.

Ongoing Monitoring & Reporting

The Ministry will ensure that an acceptable ambient air monitoring program is put it place and maintained by each of the three industries in the area: Beachville Lime, Federal White Cement and LaFarge. The following is a summary of the Ministry's action plan for air monitoring:

- Ministry has requested that each company install and operate air monitoring equipment by the spring of 2003 in accordance with an air monitoring program approved by Ministry;
- The monitoring equipment will measure Total Suspended Particulate (TSP), PM_{10}, and $PM_{2.5}$ on a continuous, real time basis;
- The Ministry will have direct access to the monitoring data;
- The Ministry will perform verification sampling of the ambient air quality and random audits of the industry monitoring equipment.

Implementation of Best Management Practices to Reduce Fugitive Emissions

Each of the three companies have been required to develop a fugitive dust abatement program based on Best Management Practices. The Ministry intends to ensure that the companies implement, maintain and update as required the measures contained within these programs to reduce fugitive emissions. Items in these fugitive dust abatement programs will include such measures as: the watering of roadways and outdoor material stockpiles, application of dust suppressants to roadways, daily inspection of particulate emission sources and site re-vegetation.

Many of these Best Management Practices have already been implemented by the industries involved. Ministry will continue to work closely with the industry to make improvements to existing practices as needed and ensure the implementation of additional practices as required.

Communications

In 2002, Zorra Township established the Zorra Aggregate Advisory Committee to address resident's concerns with the aggregate industry in the township. Through its membership, the committee represents the local municipalities, the Beachville area aggregate industry and the public. MOE, Ministry of Natural Resources and the Oxford County Board of Health also participate on the committee in an advisory capacity. Through this committee, concerns related to air quality and water taking arising from aggregate industry operations have already been brought to the ministry's attention. The MOE is committed to providing information on the status of environmental issues related to the aggregate industry to this committee on a regular basis.